

CLAIMS

1. A liquid crystal display apparatus comprising a first substrate (21b) having a first transparent electrode (22b) and a second substrate (21a) having a second transparent electrode (22a), liquid crystal devices (2) holding a nematic liquid crystal layer (24) which is twist-oriented by an STN-twist angle between the first and second substrates; a first polarization board (1) provided for an outside of the first substrate; a twisted phase difference board (3) provided for the outside of the second substrate and having liquid crystal polymer layers (32a, 32b); and a second polarization board (4) provided for the outside of the twisted phase difference board; characterized in that,

the direction of the twist angle of molecule orientation of the twisted phase difference board (3) is reverse to the direction of the twisted orientation of the liquid crystal molecule of the liquid crystal devices (2), and the twist angle of the twisted phase difference board is smaller than the twist angle of the liquid crystal devices (2) by 10° to 40° .

2. A liquid crystal display apparatus as claimed in claim 1, wherein the STN-twist angle lies in the range of 180° to 270° .

3. A liquid crystal display apparatus as claimed in claim 2, wherein

an angle between the liquid crystal molecule-oriented direction of the alignment film (23a) of the second substrate and the molecule-oriented direction of a lower polymer (32b) of the liquid crystal polymer layer lies in the range of 80° to 90° ;

an angle between an absorption axis of the first polarization board (1) and the liquid crystal molecule-oriented direction of the alignment film (23b) of the first substrate side lies in the range of 50° to 60° ; and

an angle between the absorption axis of

the second polarization board (4) and the molecule-oriented direction of an upper polymer (32a) of the liquid crystal polymer lies in the range of 30° to 40° .

4. A liquid crystal display apparatus as claimed
5 in claim 2, wherein

in the relationship between a retardation $\Delta n d_1$ obtained by product of a double refractive index Δn_1 of the nematic liquid crystal layer (24) and a thickness d_1 of the liquid crystal layer, and a
10 retardation $\Delta n d_2$ obtained by product of the double refractive index Δn_2 of the liquid crystal polymer layer and the thickness d_2 of the liquid crystal polymer layer, the retardation $\Delta n d_1$ lies in the range of 0.7 to $0.9 \mu\text{m}$, and

15 the difference $\Delta n d_1 - \Delta n d_2$ lies in the range of 0.1 to $0.3 \mu\text{m}$.

5. A liquid crystal display apparatus as claimed
in claim 2, wherein

an angle between the liquid crystal
20 molecule-oriented direction of the alignment film (23a) of the second substrate and the molecule-oriented direction of a lower polymer (32b) of the liquid crystal polymer layer lies in the range of 80° to 90° ;

an angle between an absorption axis of the
25 first polarization board (1) and the liquid crystal molecule-oriented direction of the alignment film (23b) of the first substrate side lies in the range of 50° to 60° ;

an angle between the absorption axis of
30 the second polarization board (4) and the molecule-oriented direction of an upper polymer (32a) of the liquid crystal polymer lies in the range of 30° to 40° ; and

in the relationship between a retardation
35 $\Delta n d_1$ obtained by product of a double refractive index

Δn_1 of the nematic liquid crystal layer (24) and a thickness d_1 of the liquid crystal layer, and a retardation Δn_2 obtained by product of the double refractive index Δn_2 of the liquid crystal polymer layer and the thickness d_2 of the liquid crystal polymer layer, the retardation Δn_1 lies in the range of 0.7 to 0.9 μm , and the difference $\Delta n_1 - \Delta n_2$ lies in the range of 0.1 to 0.3 μm .

6. A liquid crystal display apparatus as claimed in claim 2, wherein a preferential view direction of the liquid crystal devices (2) is set to any one direction of the hands of a clock showing two-thirty, four-thirty, seven-thirty or ten-thirty.

7. A liquid crystal display apparatus as claimed in claim 3 or 5, wherein the second polarization board (4) and the twisted phase difference board (3) structures a bonded unit; and the bond unit is structured by superposing upon the second polarization board of the rolled film and the twisted phase difference board of the rolled film, and adhering them for the same roll-out direction, by utilizing the angle between the absorption axis of the second polarization board (4) and the molecule-oriented direction of the upper polymer (32a) of the liquid crystal polymer layer being in the range of 30° to 40°.

8. A liquid crystal display apparatus as claimed in claim 7, wherein the bonding unit is structured by superposing upon the rolled films each other and adhering them for the same direction, and by cutting it to a predetermined size.

9. A liquid crystal display apparatus as claimed in claim 2, wherein the liquid crystal polymer layer of the twisted phase difference board has a temperature compensating characteristic in a predetermined temperature range.

10. A liquid crystal display apparatus as claimed
in claim 9, wherein the liquid crystal polymer layer has
a temperature compensating characteristic in which the
retardation ($\Delta n d_2$) of the liquid crystal polymer layer
5 is always smaller than the retardation ($\Delta n d_1$) of the
nematic liquid crystal layer in a predetermined
temperature range.

11. A liquid crystal display apparatus as claimed
in claim 10, wherein the predetermined temperature range
10 lies in the range of 20° to 80° .

12. A liquid crystal display apparatus comprising a
first substrate (21b) having a first transparent
electrode (22b) and a second substrate (21a) having a
second transparent electrode (22a), liquid crystal
15 devices (2) holding a nematic liquid crystal layer (24)
which is twist-oriented by an STN-twist angle in the
range of 180° to 270° between the first and second
substrates; a first polarization board (1) provided for
an outside of the first substrate; a twisted phase
20 difference board (3) provided for the outside of the
second substrate and having liquid crystal layers (32a,
32b); and a second polarization board (4) provided for
the outside of the twisted phase difference board;
characterized in that,

25 a) the direction of the twist angle of
molecule orientation of the twisted phase difference
board (3) is reverse to the direction of the twisted
orientation of the liquid crystal molecule of the liquid
crystal devices (2), and the twist angle of the twisted
30 phase difference board is smaller than the twist angle of
the liquid crystal devices (2) by 10° to 40° ;

b) an angle between the liquid crystal
molecule-oriented direction of the alignment film (23a)
of the second substrate and the molecule-oriented
35 direction of a lower polymer (32b) of the liquid crystal
polymer layer lies in the range of 80° to 90° ;

c) an angle between an absorption axis of the first polarization board (1) and the liquid crystal molecule-oriented direction of the alignment film (23b) of the first substrate side lies in the range of 50° to 60° ;

d) an angle between the absorption axis of the second polarization board (4) and the molecule-oriented direction of an upper polymer (32a) of the liquid crystal polymer lies in the range of 30° to 40° ;

e) in the relationship between a retardation $\Delta n d_1$ obtained by product of a double refractive index Δn_1 of the nematic liquid crystal layer (24) and a thickness d_1 of the liquid crystal layer, and a retardation $\Delta n d_2$ obtained by product of the double refractive index Δn_2 of the liquid crystal polymer layer and the thickness d_2 of the liquid crystal polymer layer, $\Delta n d_1$ lies in the range of 0.7 to $0.9 \mu\text{m}$, and the difference $\Delta n d_1 - \Delta n d_2$ lies in the range of 0.1 to $0.3 \mu\text{m}$;

f) the second polarization board (4) and the twisted phase difference board (3) structure a bonded unit; and the bond unit is structured by superposing upon the second polarization board of the rolled film and the twisted phase difference board of the rolled film, adhering them for the same roll-out direction, and cutting it to a predetermined size; and

g) the liquid crystal polymer layer has a temperature compensating characteristic in which the retardation ($\Delta n d_2$) of the liquid crystal polymer layer is always smaller than the retardation ($\Delta n d_1$) of the nematic liquid crystal layer in a predetermined temperature range.

13. A method for manufacturing a liquid crystal display apparatus comprising a first substrate (21b)

having a first transparent electrode (22b) and a second substrate (21a) having a second transparent electrode (22a), liquid crystal devices (2) holding a nematic liquid crystal layer (24) which is twist-oriented by an STN-twist angle in the range of 180° to 270° between the first and second substrates; a first polarization board (1) provided for an outside of the first substrate; a twisted phase difference board (3) provided for the outside of the second substrate and having liquid crystal polymer layers (32a, 32b); and a second polarization board (4) provided for the outside of the twisted phase difference board; wherein an angle between an absorption axis of the second polarization board (4) and a molecule-oriented direction of an upper polymer (32a) of the liquid crystal polymer layer lies in the range of 30° to 40° ; characterized in that,

- a) the second polarization board (4) is structured by rolled film;
- b) the twisted phase difference board is structured by the rolled film;
- c) the roll-out direction of the rolled film of the second polarization board and the roll-out direction of the rolled film of the twisted phase difference board are arranged in the same direction by utilizing an angle being in the range of 30° to 40° ;
- d) the rolled film of the second polarization board and the rolled film of the twisted phase difference board are superposed upon each other and adhered them in the roll-out direction; and
- e) a bonding unit is made by cutting the rolled film in a predetermined size after adhesion and bonding the second polarization board and the twisted phase difference board.

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